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1. GENERAL BACKGROUND INFORMATION

ABBREVIATIONS AND ACRONYMS USED IN THIS BULLETIN

BIPM	- Bureau International des Poids et Mesures		
CCIR	- International Radio Consultative Committee		
Cs	- Cesium standard		
GOES	- Geostationary Operational Environmental Satellite		
GPS	- Global Positioning System		
IERS	- International Earth Rotation Service		
LORAN	- Long Range Navigation		
MC	- Master Clock		
MJD	- Modified Julian Date		
NVLAP	- National Voluntary Laboratory Accreditation Program		
NIST	- National Institute of Standards and Technology		
NOAA	- National Oceanic and Atmospheric Administration	ns	- nanosecond
SI	- International System of Units	μs	- microsecond
TA	- Atomic Time	ms	- millisecond
TAI	- International Atomic Time	s	- second
USNO	- United States Naval Observatory	min	- minute
UTC	- Coordinated Universal Time		
VLF	- very low frequency		

2. TIME SCALE INFORMATION

The values listed below are based on data from the IERS, the USNO, and NIST. The UTC(USNO,MC) - UTC(NIST) values are averaged measurements from up to 10 GPS satellites (see bibliography on page 5). **UTC-UTC(NIST) data are on page 3.**

0000 HOURS COORDINATED UNIVERSAL TIME			
FEB 2001	MJD	UT1-UTC(NIST) (±5 ms)	UTC(USNO,MC)-UTC(NIST) (±20 ns)
1	51941	+ 77 ms	20 ns
8	51948	+ 76 ms	16 ns
15	51955	+ 69 ms	14 ns
22	51962	+ 64 ms	8 ns

The master clock pulses used by the WWV, WWVH, WWVB, and GOES time code transmissions are referenced to the UTC(NIST) time scale. Occasionally, 1 s is added to the UTC time scale. This second is called a leap second. Its purpose is to keep the UTC time scale within ±0.9 s of the UT1 astronomical time scale, which changes slightly due to variations in the rotation of the Earth.

NOTE: No positive leap second will be inserted at the end of June 2001.

Positive leap seconds, beginning at 23 h 59 min 60 s UTC and ending at 0 h 0 min 0 s UTC, were inserted in the UTC timescale on 30 June 1972, 1981-1983, 1985, 1992, 1993, 1994, and 1997, and on 31 December 1972-1979, 1987, 1989, 1990,1995, and 1998. There have been 22 leap seconds in total.

The use of leap seconds ensures that UT1 - UTC will always be held within ±0.9 s. The current value of UT1 - UTC is called the DUT1 correction. DUT1 corrections are broadcast by WWV, WWVH, WWVB, and GOES and are printed below. These corrections may be added to received UTC time signals in order to obtain UT1.

DUT1 = UT1 - UTC +
+0.2s beginning 0000 UTC 13 April 2000
+0.1s beginning 0000 UTC 19 October 2000
+0.0s beginning 0000 UTC 01 March 2001

The deviation of UTC(NIST) from UTC has been within +/- 100 ns since July 6, 1994. The table below shows values of UTC - UTC(NIST) as supplied by the BIPM in their Circular T publication for the most recent 350 day period in which data are available. Data are given at ten day intervals. Five day interval data are available in Circular T.

0000 Hours Coordinated Universal Time

DATE	MJD	UTC-UTC(NIST) ns
Feb 25, 2000	51599	7
Mar 6, 2000	51609	8
Mar 16, 2000	51619	15
Mar 26, 2000	51629	15
Apr 5, 2000	51639	20
Apr 15, 2000	51649	20
Apr 25, 2000	51659	17
May 5, 2000	51669	17
May 15, 2000	51679	17
May 25, 2000	51689	18
June 4, 2000	51699	18
June 14, 2000	51709	20
June 24, 2000	51719	23
July 4, 2000	51729	24
July 14, 2000	51739	24
July 24, 2000	51749	24
Aug 3, 2000	51759	26
Aug 13, 2000	51769	25
Aug 23, 2000	51779	22
Sep 2, 2000	51789	12
Sep 12, 2000	51799	6
Sep 22, 2000	51809	0
Oct. 2, 2000	51819	-8
Oct. 12, 2000	51829	-13
Oct. 22, 2000	51839	-19
Nov. 1, 2000	51849	-25
Nov. 11, 2000	51859	-22
Nov. 21, 2000	51869	-21
Dec. 1, 2000	51879	-16
Dec. 11, 2000	51889	-9
Dec. 21, 2000	51899	-5
Dec. 31, 2000	51909	-3
Jan. 10, 2001	51919	2
Jan. 20, 2001	51929	7
Jan. 30, 2001	51939	11

3. PHASE DEVIATIONS FOR WWVB AND LORAN-C

WWVB - The values shown for WWVB are the time differences between the time markers of the UTC(NIST) time scale and the first positive-going zero voltage crossover measured at the transmitting antenna. The uncertainty of the individual measurements is ±0.5 μs. The values listed are for 1300 UTC.

LORAN-C - The values shown for Loran-C represent the daily accumulated phase shift (in ns). The phase shift is measured by comparing the output of a Loran receiver to the UTC(NIST) time scale for a period of 24 h. If data were not recorded on a particular day, the symbol (-) is printed.

The master stations monitored are Dana, IN (8970) and Fallon, NV (9940). The monitoring is done from the NIST laboratories in Boulder, Colorado.

Note: The values shown for Loran-C are in nanoseconds.

		UTC(NIST)-WWVB (60 kHz)	UTC(NIST) - LORAN PHASE (ns)	
DATE	MJD	ANTENNA PHASE (μs)	LORAN-C (DANA) (8970)	LORAN-C (FALLON) (9940)
02/01/01	51941	5.47	-237	+78
02/02/01	51942	5.49	+165	-220
02/03/01	51943	5.49	-102	-471
02/04/01	51944	5.49	+280	-192
02/05/01	51945	5.47	-110	+178
02/06/01	51946	5.49	-119	-253
02/07/01	51947	5.47	+287	+158
02/08/01	51948	5.47	+133	+330
02/09/01	51949	5.48	+56	-12
02/10/01	51950	5.48	+136	+326
02/11/01	51951	5.48	-458	-157
02/12/01	51952	5.48	+94	-45
02/13/01	51953	5.47	+27	+217
02/14/01	51954	5.47	-339	-266
02/15/01	51955	5.47	+171	-26
02/16/01	51956	5.50	-420	+224
02/17/01	51957	5.50	+219	+355
02/18/01	51958	5.50	-200	+40
02/19/01	51959	5.49	-353	-265
02/20/01	51960	5.48	-74	+119
02/21/01	51961	5.48	-291	+281
02/22/01	51962	5.49	+152	-240
02/23/01	51963	5.48	+433	+437
02/24/01	51964	5.49	-5	+16
02/25/01	51965	5.50	-383	-99
02/26/01	51966	5.50	+69	+8
02/27/01	51967	5.48	-11	-72
02/28/01	51968	5.49	-105	+15

4. BROADCAST OUTAGES AND WWVB PHASE PERTURBATIONS

WWVB 60 kHz OUTAGES OF 5 MINUTES OR MORE							PHASE PERTURBATIONS			
Station	FEB 2001	MJD	Began UTC	Ended UTC	Freq.		FEB 2001	MJD	Began UTC	End UTC
WWVB										
WWV										
WWVH										

5. NOTES ON NIST TIME SCALE AND PRIMARY STANDARDS

Primary frequency standards developed and maintained by NIST are used to provide accuracy (rate) input to the BIPM. NIST-7, which has served as the U.S. primary standard since 1994 is being replaced by NIST-F1, a cesium fountain frequency standard. The uncertainty of the new standard is currently 1.7 parts in 10^{15}.

The AT1 scale is run in real time using data from an ensemble of cesium standards and hydrogen masers. It is a free-running scale whose frequency is maintained as constant as possible by choosing the optimum weight for each clock that contributes to the computation.

UTC(NIST) is generated as an offset from our real-time scale AT1. It is steered in frequency towards UTC using data published by the BIPM in its Circular T. Changes in the steering frequency will be made, if necessary, at 0000 UTC on the first day of the month, and very occasionally at mid-month. A change in frequency is limited to no more than ± 2ns/day. The frequency of UTC(NIST) is kept as stable as possible at other times.

UTC is generated at the BIPM using a post-processed time-scale algorithm and is not available in real-time. The parameters that we use to generate UTC(NIST) in real-time are therefore based on an extrapolation of UTC from the most recent data available.

6. BIBLIOGRAPHY

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Table 7.1 is a list of the parameters that are used to define UTC(NIST) with respect to our real-time scale AT1. To find the value of UTC(NIST) - AT1 at any time T (expressed as a Modified Julian Day, including a fraction if needed), the appropriate equation to use is the one for which the desired T is greater than or equal to the entry in the T_0 column and less than the entry in the last column. The values of x_{ls}, x, and y for that month are then used in the equation below to find the desired value. The parameters x and y represent the offset in time and in frequency, respectively, between UTC(NIST) and AT1; the parameter x_{ls} is the number of leap seconds applied to both UTC(NIST) and UTC as specified by the IERS. Leap seconds are not applied to AT1.

Table 7.1

$$UTC(NIST) - AT1 = x_{ls} + x + y\cdot(T - T_0)$$

Month	x_{ls} (s)	x (ns)	y (ns/day)	T_0 (MJD)	Valid until 0000 on: (MJD)
Jul 99	-32	-192884	-41.0	51360	51391
Aug 99	-32	-194155	-41.0	51391	51422
Sep 99	-32	-195426	-40.5	51422	51452
Oct 99	-32	-196641	-40.5	51452	51483
Nov 99	-32	-197896.5	-40.0	51483	51513
Dec 99†	-32	-199096.5	-40.0	51513	51533
Dec 99	-32	-199896.5	-41.0	51533	51544
Jan 00	-32	-200347.5	-40.5	51544	51575
Feb 00	-32	-201603	-40.5	51575	51604
Mar 00	-32	-202777.5	-40.5	51604	51635
Apr 00	-32	-204033	-40.5	51635	51665
May 00	-32	-205248	-40.25	51665	51696
Jun 00	-32	-206495.75	-40.25	51696	51725††
Jul 00	-32	-207663	-40.0	51725††	51757
Aug 00	-32	-208943	-39.5	51757	51788
Sep 00	-32	-210167.5	-39.0	51788	51818
Oct 00	-32	-211337.5	-39.0	51818	51849
Nov 00	-32	-212546.5	-40.0	51849	51879
Dec 00	-32	-213746.5	-40.0	51879	51910
Jan 01	-32	-214986.5	-40.0	51910	51941
Feb 01	-32	-216226.5	-39.0	51941	51969
Mar 01	-32	-217318.5	-39.5	51969	52000
Apr 01	-32	-218543	-39.5*	52000	52030

† Rate change in mid-month
†† Rate change one day early
*Provisional rate

7. SPECIAL ANNOUNCEMENTS

TRACEABLE FREQUENCY CALIBRATIONS
(Now NVLAP Certified)

Laboratories needing traceable frequency calibrations can get them by subscribing to the NIST Frequency Measurement and Analysis Service. This service is offered on a lease basis by NIST to provide an easy and inexpensive means to obtain traceability of a laboratory frequency standard and, in addition, to calibrate other devices in the lab. This service has been designed for ease of operation and as a practical calibration tool.

All necessary hardware and software is provided by NIST. Users must provide their own oscillator(s) and an ordinary telephone line so that NIST can access the system by modem. A total of five oscillators can be calibrated at the same time. Radio signals from GPS satellites are used and the measurement uncertainty is $\pm 2 \times 10^{-13}$ per day. Any frequency from 1 Hz to 120 MHz can be measured in 1 Hz increments.

The calibration data are displayed in color and a graph is plotted daily for each oscillator. Data are also stored on disk. The user can call up any of the data and view them onscreen or in the form of plots. Up to 5 months of data can be plotted on one graph.

The system plots are easy to read and understand. The system manual is written clearly and the NIST staff is available by telephone to assist. The modem connection allows NIST to access the data and to prepare a monthly traceability report, which is mailed to the user.

Frequency sources of any accuracy can be calibrated. The FMAS is particularly useful at the highest levels of performance. This is because each user of the system contributes information and calibration data for the others. If an uncertainty arises, it is possible for NIST to call by modem to another user nearby. In this way problems in data interpretation can be resolved.

NVLAP certification requirements for frequency measurement are met by following the NIST-FMAS operating manual. This service does not eliminate the NVLAP audits but, when installed and operated per the NIST guidelines, audit requirements are easily met.

NIST retains title to the equipment and supplies. All necessary replacement parts are replaced by overnight shipment. Training for use of the system is available if requested by the user.

The NIST Frequency Measurement and Analysis Service provides a complete solution to nearly all frequency measurement and calibration problems. For a free information package, please contact Michael Lombardi at (303) 497-3212, E-mail at lombardi@boulder.nist.gov, or write to: Michael Lombardi, NIST, Division 847, 325 Broadway, Boulder, CO 80303.

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